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## Bio-inspired aesthetic solar cells

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In nature by far the largest amount of energy comes from the sun, and through synthesis in plants, it is the basis for the existence of all other organisms. However, we human beings are not very good at directly utilizing the solar energy. Denmark only produced 0.9 PJ solar heat which equals 0.6 % of the entire production of distance heating. The potential is 30PJ solar heat if placed on buildings [1]. In 2013 Denmark produced 518 GWh (1.9PJ) of electricity from solar power, which equals 1.5% of the electricity consumption [1]. The question is why these numbers are not larger? One reason could be that the appearance of solar collectors and photo voltaic cells do not match the requirements from users, which request aesthetic acceptable solutions. Existing solar cells and panels are all black or other dark colours and the surface texture is very different from existing roof and façade materials. This is most often very difficult to incorporate into existing buildings with an aesthetic acceptable result.



In a preliminary study the requirements for more aesthetic appearances has been analysed and needs been identified [2]. These include better options for incorporating the geometry of solar cell panels in buildings and for a broader range of appearance properties (colours, patterns). A modular system of smaller solar cells is proposed, which allow for individual adaption to the specific geometry of house facades. 15 x 15 cm modules are individually assembled at the factory into either 12 or 24 volt panels which are mounted at the façade using traditional façade mounting rails. Colours and patterns are proposed made using structural colours similar to the way nature solves the combined challenge of both requesting reflection and transmission. Structural colours reflect a fraction of the incoming light while allowing the remainder of the light through as transmission. In this way a large portion of the solar energy can pass through the colour reflector and supply the solar cells. In nature many insects and other organisms use structural colours to achieve spectacular appearances or the reverse highly efficient camouflage. The structural colours often vary depending of the viewing angle, which normally would not be desired for outer surfaces on buildings. One way of solving this is to apply plasmonic metasurface coatings [3] either directly to the solar cell or to the coating glass. Another option is to use twisted birefringent nematic structures, as done by the golden beetle *Plusiotis resplendens* [4].

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